The iterative physical optics (IPO) method is applied to computing the waveguide modal scattering matrices (S-matrices) of an electrically large cavity, such as a jet engine inlet or exhaust duct. The cavity may have one or two ports, and the extension to N ports is discussed. The S-matrices may be used to connect up sections of duct and the termination, and to compute the radar cross section of the composite structure. The computer code IPOMODT has been developed under this work. This report also serves as a user manual for the code. Numerical examples are included and compared with the finite element/modal theory (FEM/ModT) method.